PB88-129580

Health and Environmental Effects Profile for Merphos Oxide

(U.S.) Environmental Protection Agency
Cincinnati, OH

Jan 84

U.S. Department of Commerce
National Technical Information Service
NTIS

PB88-129560

EPA/600/X-84/202
January 1984

HEALTH AND ENVIRONMENTAL EFFECTS PROFILE FOR MERPHOS OXIDE

ENVIRONMENTAL CRITERIA AND ASSESSMENT OFFICE
OFFICE OF HEALTH AND ENVIRONMENTAL ASSESSMENT
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OH 45268

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/X-84-202	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE Health and Environmental Effects Profile for Merphos Oxide	5. REPORT DATE January 1984
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Criteria and Assessment Office Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE EPA/600/22
15. SUPPLEMENTARY NOTES	

16. ABSTRACT

The Health and Environmental Effects Profile for merphos oxide was prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Solid Waste to support listings of hazardous constituents of a wide range of waste streams under Section 3001 of the Resource Conservation and Recovery Act (RCRA). Both published literature and information obtained from Agency program office files were evaluated as they pertained to potential human health, aquatic life and environmental effects of hazardous waste constituents.

Quantitative estimates have been presented provided sufficient data are available. Merphos oxide has been determined to be a systemic toxicant. An Acceptable Daily Intake (ADI), defined as the amount of a chemical to which humans can be exposed on a daily basis over an extended period of time (usually a lifetime) without suffering a deleterious effect, for merphos oxide is 2.5×10^{-3} (mg/kg bw/day) for oral exposure.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field Group

18. DISTRIBUTION STATEMENT Public	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 33
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

Health and Environmental Effects Profiles (HEEPs) are prepared for the Office of Solid Waste by the Office of Health and Environmental Assessment. The HEEPs are intended to support listings of hazardous constituents of a wide range of waste streams under Section 3001 of the Resource Conservation and Recovery Act (RCRA). Both published literature and information obtained from Agency program office files are evaluated as they pertain to potential human health, aquatic life and environmental effects of hazardous waste constituents. The literature searched and the dates of the searches are included in the section titled "Appendix: Literature Searched."

Quantitative estimates are presented provided sufficient data are available. For systemic toxicants, these include, Acceptable Daily Intakes (ADIs) for chronic exposures. An ADI is defined as the amount of a chemical to which humans can be exposed on a daily basis over an extended period of time (usually a lifetime) without suffering a deleterious effect. In the case of suspected carcinogens, ADIs are not estimated in this document series. Instead, a carcinogenic potency factor or q_1^* is provided. These potency estimates are derived for both oral and inhalation exposures where possible. In addition, unit risk estimates for air and drinking water are presented based on inhalation and oral data, respectively.

The first draft of this document was prepared by Syracuse Research Corporation under EPA Contract No. 68-03-3228. The document was subsequently revised after reviews by staff within the Office of Health and Environmental Assessment: Carcinogen Assessment Group, Reproductive Effects Assessment Group, Exposure Assessment Group, and the Environmental Criteria and Assessment Office in Cincinnati.

The HEEPs will become part of the EPA RCRA docket.

ACKNOWLEDGEMENTS

The initial draft of this report was prepared by Syracuse Research Corporation under Contract No. 68-03-3228 for U.S. EPA's Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. Dr. Christopher DeRosa was the Technical Project Monitor and Helen Ball was the Project Officer. The final documents in this series were prepared for the Office of Solid Waste, Washington, DC.

Scientists from the following U.S. EPA offices provided review comments for this document series:

Environmental Criteria and Assessment Office, Cincinnati, OH
Carcinogen Assessment Group
Exposure Assessment Group
Reproductive Effects Assessment Group

Editorial review for the document series was provided by:
Judith Olsen and Erma Durden
Environmental Criteria and Assessment Office, Cincinnati, OH

Technical support services for this document series were provided by:
Bette Zwayer, Pat Daunt, Karen Mann, and Jacky Bohanon
Environmental Criteria and Assessment Office, Cincinnati, OH.

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
1.1.	STRUCTURE AND CAS NUMBER	1
1.2.	CHEMICAL AND PHYSICAL PROPERTIES	1
1.3.	PRODUCTION DATA	2
1.4.	USE DATA	2
2.	ENVIRONMENTAL FATE AND TRANSPORT PROCESSES	3
3.	MONITORING-EXPOSURE	6
4.	PHARMACOKINETICS	7
5.	EFFECTS	8
5.1.	CARCINOGENICITY	8
5.2.	MUTAGENICITY	8
5.3.	TERATOGENICITY	8
5.4.	OTHER REPRODUCTIVE EFFECTS	9
5.5.	CHRONIC TOXICITY	9
5.6.	OTHER RELEVANT INFORMATION	10
6.	AQUATIC TOXICITY	13
6.1.	ACUTE TOXICITY	13
6.2.	CHRONIC	14
6.3.	PLANT EFFECTS	15
6.4.	RESIDUE	15
6.5.	OTHER RELEVANT INFORMATION	15
7.	EXISTING GUIDELINES AND STANDARDS	16
7.1.	HUMAN	16
7.2.	AQUATIC	16
8.	RISK ASSESSMENT	17
9.	REFERENCES	18
APPENDIX:	LITERATURE SEARCHED	25

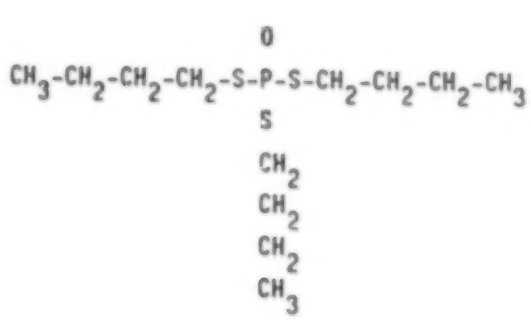
LIST OF ABBREVIATIONS

ADI	Acceptable daily intake
bw	Body weight
HRP	Horseradish peroxidase
i.p.	Intraperitoneal
LC_{50}	Concentration lethal to 50% of recipients
LD_{50}	Dose lethal to 50% of recipients
MATC	Maximum acceptable toxicant concentration
ppm	Parts per million
SCE	Sister chromatid exchange

1. INTRODUCTION

1.1. STRUCTURE AND CAS NUMBER

Merphos oxide is a synonym for phosphorotrithioic acid, S,S,S-tributyl ester. This compound is also known as S,S,S-tributyl phosphorotrithioate; butyl phosphorotrithioate; Butifos, Butiphos; DEF; DEF Defoliant; DE-GREEN; E-Z -OFF D; Fos-Fall A; Chemagro 1776; and ortho phosphate defoliant (NIOSH, 1983). Merphos oxide was first introduced under the code number Chemagro B-1776 and the trademark DEF Defoliant by Chemagro Corporation in 1956 (BCPC, 1977). The structure of merphos oxide is given below (U.S. EPA/NIH, 1983):



Molecular Formula: $C_{12}H_{27}OPS_3$

Molecular Weight: 314.3

The Chemical Abstracts Service (CAS) Registry Number for this chemical is 78-48-8.

1.2. CHEMICAL AND PHYSICAL PROPERTIES

Merphos oxide is a colorless to pale yellow liquid, with an odor similar to mercaptan (BCPC, 1977; Ouellette and King, 1977) and the following characteristics:

Boiling Point:	150°C at 0.3 mm Hg (BCPC, 1977)
Melting Point:	-25°C (BCPC, 1977)
Density (d^{20}):	1.06 (BCPC, 1977)

Vapor Pressure:	1.38×10^{-5} mm Hg at 30°C (Hermann and Seiber, 1981)
Solubility:	Virtually insoluble in water; soluble in most organic solvents (BCPC, 1977)
Stability:	Stable to heat and acid; hydrolyzed slowly under alkaline conditions (BCPC, 1977)
Log $K_{o/w}$:	5.7 (U.S. EPA, 1981)

1.3. PRODUCTION DATA

Merphos oxide is manufactured by Phillips Petroleum Co., Philtex Plant, Hutchinson County, Texas (U.S. EPA, 1983; SRI, 1982) for Mobay Chemical Corporation, Chemagro Agricultural Division (SRI, 1976). There is no listing for this herbicide in the 1983 edition of the Directory of Chemical Producers (SRI, 1983). Lawless et al. (1972) indicated that in 1971, merphos oxide was produced by Chemagro, Kansas City, Missouri, with an estimated U.S. Pesticide Volume Production of 5 million pounds of active ingredient.

Merphos oxide is prepared by the reaction of 1-butanethiol with phosphorus oxychloride in the presence of a base (BCPC, 1977).

1.4. USE DATA

Merphos oxide is used as cotton defoliant at 1.0-2.0 kg active ingredient/ha (BCPC, 1977). The fact that merphos oxide is listed in the 1977 TSCA production file (U.S. EPA, 1983) suggests that merphos oxide has uses other than as a pesticide (e.g., as an intermediate in chemical synthesis).

2. ENVIRONMENTAL FATE AND TRANSPORT PROCESSES

Information on the fate and transport of merphos oxide in the environment is limited. As an agricultural chemical sprayed onto soil, the herbicide may enter the aquatic environment sorbed to particulate matter in runoff water.

The fate of merphos oxide in the aquatic environment will depend upon its ability to undergo chemical and photochemical reactions and to be biodegraded. Experiments on the persistence of merphos oxide in aquatic systems (U.S. EPA, 1981) indicated that microbial degradation was an important process in its disappearance. About 20% of the added pesticide remained in non-sterile sediment/water systems after 5 days, while 38 and 77% were still detected after 7 days in seawater (no sediment) and in sterile sediment/water, respectively. In the non-sterile seawater, 12% of the added merphos oxide was lost through evaporation into the atmosphere in 7 days and 50% was lost through hydrolysis. It was suggested that the hydrolysis of merphos oxide in the other aquatic system was reduced due to extensive sorption (77%) to sediment. Although extensive hydrolysis occurred in the previous study (U.S. EPA, 1981), Hermann (1981) stated that merphos oxide is stable to hydrolysis. If the hydrolysis was biologically mediated, this apparent inconsistency is resolved.

Eichelberger and Lichtenberg (1971) reported that recovery of merphos oxide from river water treated with merphos (10 µg/ℓ) and stored in a jar under sunlight and artificial fluorescent lighting was 50% after 1 week, 30% after 2 weeks, 10% after 4 weeks and <5% after 8 weeks.

Transport of merphos oxide in the aquatic environment may occur by volatilization into the air or by sorption to sediment (U.S. EPA, 1981). In addition, the high log [octanol/water partition coefficient] (5.7) suggests

that merphos oxide will accumulate in aquatic animals (U.S. EPA, 1981); however, this does not take into account the rate at which merphos oxide is metabolized in aquatic organisms.

Merphos oxide can enter the atmosphere through spray drift during application or by evaporation from the soil surface after application (or evaporation from water). Hermann and Seiber (1981) detected airborne merphos oxide in samples taken 50 m from treated cotton fields during spraying, and 24 and 72 hours after the application of 2.2 kg/ha, at which times the concentrations were 1189, 450 and 24 ng/m^3, respectively.

The fate of the herbicide in air will depend upon its ability to react with ozone, NO_x and free radicals, and its ability to undergo photolysis. Merphos oxide was fairly stable in both a laboratory vapor-phase photoreactor and a field spray drift test (Woodrow et al., 1983). A slow breakdown to phosphorus-containing acids in the presence of ozone was observed in the laboratory, but this reaction was too slow to measure in field spray drift experiments. Hermann (1981) stated that the photostability of merphos oxide is measured in weeks (as opposed to seconds for the herbicide merphos), and that much lower atmospheric levels of 1-butanethiol were obtained from field application of merphos oxide than from merphos. After merphos oxide was applied to cotton foliage in a laboratory chamber, no 1-butanethiol was detected in the air sampled for several days. Thus, merphos oxide appeared to be stable in air under environmental and laboratory conditions.

Transport of merphos oxide in the air is likely to occur by drift. In the field study by Hermann and Seiber (1981), residue levels of merphos oxide (10 ng/m^3) were detected prior to the test application, presumably representing drift from other treated locations near the test field.

Removal of merphos oxide from the atmosphere by wet or dry deposition may occur when the chemical sorbs to particulate matter. Based on its water solubility and octanol/water partition coefficient, merphos oxide will probably sorb to particles in the air.

The fate of merphos oxide in soil will depend upon its ability to undergo chemical, photochemical and biodegradative processes. No information was available on the microbial degradation of merphos oxide in soil; however, data from water persistence studies (U.S. EPA, 1981) indicate that substantial degradation (~57%) occurred by biological processes in non-sterile water/sediment when compared with results obtained in sterile water/sediment. Hermann (1981) stated that merphos oxide was non-polar and stable to light and hydrolysis. No information was available on the transport of merphos oxide in soil; however, based on its sorption to sediment in aquatic systems (U.S. EPA, 1981), it is possible to predict that the herbicide will sorb tightly to soil, rather than leach into groundwater. Merphos oxide may then be carried into the aquatic environment sorbed to soil particles in runoff waters. Volatilization from the soil surface into the atmosphere may also represent a transport mechanism for merphos oxide, since results of water persistence studies (U.S. EPA, 1981) indicate that 12% of the added merphos oxide was lost through evaporation from seawater in 7 days.

3. MONITORING-EXPOSURE

STORET contains information on 527 stations sampled for merphos oxide with the following gross analysis:

	Water (µg/ℓ)	Mud (µg/kg)	Total (µg/ℓ)
No. of Samples	1262	21	316
Maximum	19.1	0.00	5.0
Minimum	0.00	0.00	0.00
Mean	0.02	0.00	0.82

Of nine air sampling sites around the country, merphos oxide was found only in samples of air in a rural community of Stoneville, Mississippi, at a level of 4.8-16 ng/m³ (Stanly et al., 1971).

Data from the National Soils Monitoring Program revealed that merphos oxide was detected in 4 of 1141 composite soil samples collected from 37 states (minimum 0.06 ppm, maximum 0.67 ppm; in Mississippi and Nebraska) in 1971 and in 4 of 1246 samples (minimum 0.06 ppm, maximum 0.67 ppm; in California, Louisiana and Mississippi) in 1972 (Carey et al., 1978, 1979).

4. PHARMACOKINETICS

Only limited information was located on the absorption, distribution, metabolism and excretion of merphos oxide. Kuchak (1972) reported that 69-93% of the merphos oxide administered to rabbits (0.7-3.5 mg/m^3 in air) was absorbed during a 1-hour exposure. Prolonged exposure results in cumulative toxicological properties (Ibadullaev et al., 1972).

Based on the acute toxicity data (Section 5.6.), it may be assumed that merphos oxide is readily absorbed following dermal or oral exposure.

5. EFFECTS

5.1. CARCINOGENICITY

Pertinent data regarding the carcinogenicity of merphos oxide were not located in the available literature. This chemical is not scheduled for testing by the National Toxicology Testing Program (NTP, 1983).

5.2. MUTAGENICITY

Chen et al. (1982a,b) tested 17 organophosphorus compounds for induction of SCE in Chinese hamster cells (V79) with or without a rat liver S-9 activation system. Merphos oxide did not significantly increase the incidence of SCEs in V79 cells treated for 32 hours with merphos oxide at a concentration of 2.5-20 µg/mℓ; however, significant dose related delays in the cell-cycle were observed.

Ergashev and Sultanov (1979) reported that treatment of tetraploid cotton or diploid Gossypium herbaceum seed in merphos oxide (1.5 mg/mℓ) for 4, 6 or 8 hours resulted in a dose-dependent increase in chromosome mutations; however, the applicability of this observation to mammalian systems is questionable.

5.3. TERATOGENICITY

The only information regarding the teratogenic or embryotoxic effects of merphos oxide in mammals was obtained from abstracts of Russian studies.

Mirkhamidova et al. (1981) reported alterations in hepatic structure and function in the embryos of rabbits given a single dose of merphos oxide (dose, route and time during pregnancy not specified). The morphology of the nuclei and mitochondria was altered and cytochrome C oxidase and NADH oxidase activities were lowered.

Kasymova (1975, 1976) reported that oral administration of merphos oxide ($0.1 \times LD_{50}$) on days 16-17 of pregnancy induced premature parturition and

bleeding in rats. Administration of 1/250 of the LD_{50} on day 3 resulted in an increased preimplantation mortality. Administration of 12.5 or 24.5 mg/kg on day 3 of pregnancy resulted in increased embryo mortality and decreased fetal weight and size; however, lesser effects were observed when merphos oxide was administered on day 10. In the same abstract, occupational exposure was reported to produce teratogenesis, stillbirths, rupture of the uterus, increased blood loss and aggravated parturition in agricultural workers.

5.4. OTHER REPRODUCTIVE EFFECTS

In an abstract of a Russian paper, Zak and Ergashev (1980) reported the results of administration of merphos oxide in oil (18.0, 9.0 and 4.5 mg/kg) to female rats daily for 12 days. The rats were then sacrificed at various times over the next 2 months so that various periods of the estrus cycle were observed. At the high dose, merphos oxide decreased the size of the ovaries and the uterus. Also observed at this dose were atrophic changes and vascularization of the endometrial glands, multiple cystic follicles in the ovaries and lymphocytic histiocytic infiltration in the muscle wall of the uterus. The two lower doses resulted in no morphological or histological changes in the ovaries or uteri.

5.5. CHRONIC TOXICITY

Khamraev (1973a,b,c) administered 7 mg merphos oxide/kg to dogs by daily intragastric intubation for up to 90 days. After one administration, dicytosomal inclusions, a decreased number of secretory granules and disturbed mitochondrial organization were observed in the stomach. After 3 months, extensive atropic foci in the fundal and pyloric section of the stomach, accompanied by nuclear pyknosis and cytoplasmic vacuolization, were observed. Epithelial hyperplasia occurred during partial recovery.

Functionally, this treatment stimulated gastric secretion, increasing the acidity of the stomach contents and pepsin activity, and inhibiting motor function in the stomach.

5.6. OTHER RELEVANT INFORMATION

The acute toxicity of merphos oxide to various species is summarized in Table 5-1. The odor of this compound is perceptible at an air concentration of 0.0002 mg/ℓ (Danilova and Smetanin, 1964).

Graham (1980) investigated the effect of merphos oxide on the uptake of norepinephrine (inhibition is symptomatic of delayed neurotoxicity) in two human adrenergic neuroblastoma cell lines, IMR-32 and LA-N-1. The inhibitory effect of merphos oxide was less than that of merphos, but greater than parathion and TOCP.

Bajwa and Fujimoto (1983) investigated the effect of merphos oxide on the biliary excretion of sucrose, mannitol and HRP, in male Sprague-Dawley rats administered the compound by direct intrabiliary injection (40 µℓ). They found that biliary excretion of intravenously administered manitol and sucrose was decreased, while there was an increase in the excretion of HRP. Since the two sugars enter the bile by simple diffusion and HRP enters the bile by vesicular transport, it was suggested that merphos oxide decreased membrane permeability while increasing vesicular transport.

In an abstract of a Russian paper, Kadyrov et al. (1982) reported that administration of merphos oxide (0.33 LD_{50}) to rats decreased the activity of all intestinal enzymes tested (monoglyceride lipase, alkaline phosphatase, invertase and dipeptidase) at 6 hours after dosing. Monoglyceride lipase decreased by the greatest extent (14.3-fold) and dipeptidase decreased the least (extent not given). In atropinized rats, there was no

TABLE 5-1

Acute Toxicity of Merphos Oxide

Species	Route	LD_{50}	Reference
Rat	oral	150 mg/kg	NIOSH, 1983
Rat	oral	310 mg/kg	Danilova and Smetanin, 1964
Guinea pig	oral	260 mg/kg	NIOSH, 1983
Guinea pig	oral	130 mg/kg	Danilova and Smetanin, 1964
Rabbit	oral	140 mg/kg	Danilova and Smetanin, 1964
Mouse	oral	530 mg/kg	Danilova and Smetanin, 1964
Rat	i.p.	210 mg/kg	NIOSH, 1983
Mouse	i.p.	290 mg/kg	NIOSH, 1983
Guinea pig	i.p.	150 mg/kg	NIOSH, 1983
Rat	dermal	168 mg/kg	NIOSH, 1983
Rabbit	dermal	<300 mg/kg	Danilova and Smetanin, 1964

i.p. = intraperitoneal

change in the activity of the enzymes studied with the exception of monoglyceride lipase, which was decreased, but only by 2.5-fold. This implied that the decrease is mediated by a nervous mechanism.

Merphos oxide has also been reported to induce a large dose-related fall in the body temperature of Wistar rats and LAC A mice following intraperitoneal or intravenous administration over the dose range of 20-200 mg/kg (Ray, 1980; Little and Ray, 1979).

6. AQUATIC TOXICITY

6.1. ACUTE TOXICITY

The 48-hour LC_{50} for the bluegill, Lepomis macrochirus, was 36 µg merphos oxide/ℓ (FWPCA, 1968). Johnson and Finley (1980) reported a 96-hour LC_{50} value for merphos oxide in the bluegill to be 620 µg/ℓ. The rainbow trout was similarly sensitive, with a 96-hour LC_{50} value of 660 µg/ℓ (Johnson and Finley, 1980).

The marine spot, Leiostomus xanthurus, had 24- and 48-hour LC_{50} values of 320 and 240 µg/ℓ, respectively (FWS, 1965). The spot, L. xanthurus, tested in static conditions had a 96-hour LC_{50} at 158 µg merphos oxide/ℓ (U.S. EPA, 1981). In a flowthrough system the 96-hour LC_{50} value for L. xanthurus was reduced to 130 µg merphos oxide/ℓ. Similarly, the 96-hour LC_{50} values for sheepshead minnow, Cyprinodon variegatus, determined in static and flowthrough tests were 440 and >440 µg merphos oxide/ℓ, respectively. The flowthrough 96-hour LC_{50} value of merphos oxide to pinfish, Lagodon rhomboides, was 290 µg/ℓ.

Five species of shrimp were exposed to merphos oxide in static and flowthrough systems (FWS, 1965; U.S. EPA, 1981). The mysid shrimp, Mysidopsis bahia, having static and flowthrough 96-hour LC_{50} values of 5.8 and 4.6 µg/ℓ, respectively, was the most sensitive species tested. The static 96-hour LC_{50} value for the white shrimp, Penaeus stylirostris, was 25 µg merphos oxide/ℓ. The 96-hour LC_{50} values of merphos oxide to pink shrimp, Penaeus duocarum, and grass shrimp, Palaemonetes pugio, determined in flowthrough tests were 14 and 22 µg/ℓ (U.S. EPA, 1981). The flowthrough 24- and 48-hour EC_{50} values for mortality or loss of equilibrium in the brown shrimp, Penaeus aztecus, were 28 µg merphos oxide/ℓ for both exposure intervals (FWS, 1965).

The static 48-hour EC_{50} for abnormal development and mortality in embryos of the oyster, Crassostrea virginica, was determined to be 197 µg merphos oxide/ℓ (U.S. EPA, 1981). The concentrations of merphos oxide necessary to cause a 50% decrease in shell growth in the oyster during a 96-hour exposure were 380 and 100 µg/ℓ when tested in 27 and 10°C water, respectively (FWS, 1964).

The median lethal concentration of merphos oxide for Fowler's toad tadpoles exposed for 24 hours was 1200 µg/ℓ (Sanders, 1970).

The 24- and 48-hour LC_{50} value for the freshwater scud, Gammarus lacustris, was 360 µg/ℓ (Sanders, 1969) and 230 µg/ℓ (FWPCA, 1968), respectively. The 96-hour LC_{50} for G. fasciatus was 100 µg/ℓ (Johnson and Finley, 1980).

Sanders and Cope (1968) reported that stonefly naiads, Pteronarcys californica, were comparatively resistant to merphos oxide with 24-, 48- and 96-hour LC_{50} values at 3800, 2800 and 2100 µg/ℓ, respectively. FWPCA (1968) reported a 48-hour LC_{50} of 2300 for P. californica.

5.2. CHRONIC

In life-cycle toxicity testing, mysid shrimp, M. bahia, were exposed to 0.34, 0.68, 1.7 and 3.3 µg merphos oxide/ℓ for 28 days in a flowthrough system (U.S. EPA, 1981). No shrimp survived for the duration at 3.3 µg merphos oxide/ℓ. Survival was significantly reduced at 0.68 and 1.7 µg merphos oxide/ℓ, but not at 0.34 µg/ℓ. Reproductive capacity, measured as the number of young produced per female, was reduced by at least 50% at all exposure levels (0.34, 0.68 and 1.7 µg/ℓ). Reproduction was completely inhibited at 1.7 µg merphos oxide/ℓ. Based on these data, the MATC suggested was <0.34 µg merphos oxide/ℓ (U.S. EPA, 1981).

The toxicity of merphos oxide to various stages of the Dungeness crab, Cancer magister, was tested to determine a MATC for the most sensitive life stage (Caldwell, 1979; Caldwell et al., 1979). The zoeal stage was more sensitive than the hatching egg, prezoeal, juvenile and adult stages. The MATC for zoeal stages exposed continuously to merphos oxide was determined to be 4 µg/ℓ (Caldwell, 1979), since zoeal growth was retarded at 6.9 µg/ℓ (Caldwell et al., 1979).

6.3. PLANT EFFECTS

The static 96-hour EC_{50} value for decreased growth measured spectrophotometrically in marine and estuarine algae, Skeletonema costatum, was 366 µg/ℓ (Walsh and Alexander, 1980; U.S. EPA, 1981). The no-effect level was reported at 200 µg/ℓ. At 1000 µg merphos oxide/ℓ for 4 hours, productivity of a culture of natural phytoplankton was reduced by 75.3% (FWS, 1964).

6.4. RESIDUE

Merphos oxide is reported to decompose within 8 weeks in river water (Eichelberger and Lichtenberg, 1971). Data on residues of merphos oxide in the natural aquatic environment were not located in the available literature.

6.5. OTHER RELEVANT INFORMATION

Merphos oxide was found to be a potent inhibitor of carboxylesterases from muscle of the mosquito fish, Gambusia affinis (Whitmore and Hodges, 1978).

7. EXISTING GUIDELINES AND STANDARDS

7.1. HUMAN

Ubaidullaev and Khasanov (1979) recommended an average daily maximum allowable concentration in air of 0.01 mg/m^3. No other guidelines or standards were encountered.

7.2. AQUATIC

Guidelines and standards for the protection of aquatic organisms from the toxic effects of merphos oxide were not located in the available literature.

8. RISK ASSESSMENT

No information on the possible carcinogenicity of merphos oxide was found in the available literature. Published data are inadequate to assess the mutagenicity of merphos oxide.

Information on the toxicity of merphos oxide is derived from abstracts of Russian studies. These reports indicate that merphos oxide was embryotoxic in rats at single oral doses of 12.5-24.5 mg/kg bw, with the time during gestation at which treatment occurred influencing the relative toxicity (Kasymova, 1975, 1976). In addition, Zak and Ergashev (1980) reported that repeated treatment (12 consecutive days) with merphos oxide at doses between 4.5 and 18 mg/kg resulted in atrophic changes in the ovaries and uterus of rats. The Russian literature also reports a 90-day subchronic toxicity study in dogs (Khamraev, 1973a,b,c). Daily oral doses of merphos oxide at 7 mg/kg bw resulted in degenerative changes in the stomach. These abstracts, however, contain insufficient detail for the derivation of an ADI.

Statements concerning available literature in this document refer to published, quotable sources and are in no way meant to imply that confidential data, which this document could not address, are not in existence. These data, which are considered Confidential Business Information (CBI), are available in summary form as a CBI Appendix that can be accessed by individuals with appropriate clearance. Conclusions from the CBI Appendix regarding risk assessment can, however, be presented in this chapter.

The CBI Appendix in this document reviews other animal studies from which an ADI of 0.0025 mg/kg bw/day or 0.175 mg/day for a 70 kg man was derived using an uncertainity factor of 100 (10 for interspecies extrapolation and 10 to protect the most sensitive humans within the population) was used to derive the ADI. The ADI was based on a NOEL of 0.25 mg/kg bw/day from a 2-year dietary study using rats. The dose of 1.25 mg/kg bw/day for brain cholinesterase activity inhibition in this study was the LOAEL.

9. REFERENCES

Bajwa, R.S. and J.M. Fujimoto. 1983. Effect of colchicine and S,S,S-tributyl phosphorotrithioate (DEF) on the biliary excretion of sucrose, mannitol, and horseradish peroxidase in the rat. Biochem. Pharmacol. 32: 85-90.

BCPC (British Crop Protection Council). 1977. Pesticide Manual, 5th ed., H. Martin and C.R. Worthing, Ed. p. 520.

Caldwell, R.S. 1979. Biological Effects of Pesticides on the Dungeness Crab. NTIS PS-790. (Cited in Toxline)

Caldwell, R.S., D.V. Buchanan, D.A. Armstrong, M.H. Mallon and R.E. Milleman. 1979. Toxicity of the herbicides 2,4-D, DEF, propanil and trifluralin to the dungeness crab, Cancer magister. Arch. Environ. Contam. Toxicol. 8: 383-396.

Carey, A.E., J.A. Gowen, H. Tai, W.G. Mitchell and G.B. Wiersma. 1978. Pesticide residue levels in soils and crops, 1971 -- National Soils Monitoring Program III. Pestic. Monit. J. 12: 117-136.

Carey, A.E., J.A. Gowen, H. Tai, W.G. Mitchell and G.B. Wiersma. 1979. Pesticide residue levels in soils and crops from 37 states, 1972 -- National Soils Monitoring Program IV. Pestic. Monit. J. 12(4): 209-229.

Chen, H.H., S.R. Sirianni and C.C. Huang. 1982a. Sister-chromatid exchanges in Chinese hamster cells treated with seventeen organophosphorus compounds in the presence of a metabolic activation system. Environ. Mutagen. 4: 621-624.

Chen, H.H., S.R. Sirianni and C.C. Huang. 1982b. Sister-chromatid exchanges and cell-cycle delay in Chinese hamster V79 cells treated with 9 organophosphorus compounds (8 pesticides and 1 defoliant). Mutat. Res. 103: 307-313.

Danilova, R.I. and N.I. Smetanin. 1964. Toxic properties of butiphos, a new defoliant of cotton. Med. Zh. Uzbekistana. 5: 24-28. (CA 71: 15278b)

Eichelberger, J.W. and J.J. Lichtenberg. 1971. Persistence of pesticides in river water. Environ. Sci. Technol. 5: 541-544.

Ergashev, A.K. and A.S. Sultanov. 1979. Mutagenic effect of defoliants in cotton cells and some problems of protection of hereditary structures. Uzb. Biol. Zh. 1: 71-74. (CA 90: 146703m)

FWPCA (Federal Water Pollution Control Administration). 1968. Water Quality Criteria Report of the Natl. Techn. Adv. Comm. to the Secretary of the Interior, USDI, Washington, DC.

FWS (Fish and Wildlife Service). 1964. Pesticide - Wildlife Studies, 1963. A Review of Fish and Wildlife Service Investigations During the Calender Year. USDI, Fish Wildl. Serv., Circular 199. Washington, DC.

FWS (Fish and Wildlife Service). 1965. Effects of Pesticides on Fish and Wildlife: 1964 Research Findings of the Fish and Wildlife Service. USDI, Fish Wildl. Serv., Circular 226. Washington, DC.

Graham, D.G. 1980. Development of an *in vitro* model for screening organophosphates for neurotoxicity. EPA 600/1-80-016. PB 80-169428. 43 p.

Hermann, B.W. 1981. Atmospheric residues of the defoliants DET, Folex, and their sulfur-containing byproducts near treated cotton fields. Diss. Abstr. Int. B41(11): 4104.

Hermann, B.W. and J.N. Seiber. 1981. Sampling and determination of S,S,S-tributyl phosphorotrithioate, dibutyl disulfide, and butyl mercaptan in field air. Anal. Chem. 53(7): 1077-1082.

Ibadullaev, F., R.Khi. Khaitov and F. Khalikov. 1972. Toxicodynamics of the defoliant Butiphos. Tr. Uzb. Nauch.-Issled. Inst. Vet. 20: 354-357. (CA 81: 58971f)

Johnson, W.W. and M.T. Finley. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. USDI Fish Wildl. Serv., Resource Publ. 137. Washington, DC.

Kadyrov, U.Z., U.B. Zakirov and E.A. Volokhvyanskii. 1982. Enzymatic activity of the small intestine in acute Butiphos poisoning. Med. Zh. Uzb. 6: 46-48. (CA 97: 105312j)

Kasymova, R.A. 1975. Embryotoxic effect of Butiphos. Uzb. Biol. Zh. 19: 30-32. (CA 84: 999s)

Kasymova, R.A. 1976. Experimental and clinical data on the embryotoxic effect of Butiphos. Probl. Gig. Organ. Zdravookhr. Uzb. 5: 101-103. (CA 90: 146692g)

Khamraev, A.Kh. 1973a. Morphological characteristics of the stomach mucous membranes of dogs during Butiphos poisoning. Probl. Gig. Organ. Zdravookhr. Uzb. 1: 120-121. (CA 85: 104926c)

Khamraev, A.Kh. 1973b. Effect of Butiphos on the gastric secretory and motor activity in dogs. Tr. Uzb. Nauchno-Issled. Vet. Inst. 23: 190-193. (CA 83: 202545f)

Khamraev, A.Kh. 1973c. State of cover epithelial cells of the gastric mucous membrane in dogs with chronic Butiphos poisoning. Tr. Uzb. Nauchno-Issled. Vet. Inst. 23: 189-190. (CA 83: 202544e)

Kuchak, Y.A. 1972. Absorption of the vapor phase of organophosphorus pesticides by the respiratory system of animals. Farmakol. Toksikol. (Kiev.) 7: 140-142. (CA 79: 62344e)

Lawless, E.W., R. von Rumker and T.L. Ferguson. 1972. The Pollution Potential in Pesticide Manufacturing. Prepared by Midwest Research Institute under Contract No. 69-01-0142. U.S. EPA, Office of Water Programs. Tech. Studies Report TS-00-72-04.

Little, R.A. and D.E. Ray: 1979. Tributyl S,S,S-phosphorotrithioate (DEF), a potential tool in thermoregulation research. Proc. B.P.S., April 4-6, 1979, 438 p.

Mirkhamidova, P., A.K. Mirakhmedova, G.A. Sagatova, A.V. Isakova and D. Kh. Khamidov. 1981. Effect of Butiphos on the structure and function of rabbit embryo liver. Uzb. Biol. Zh. 5: 45-47. (Rus.) (CA 96:117171e)

NIOSH (National Institute for Occupational Safety and Health). 1983. RTECS (Registry of Toxic Effects of Chemical Substances). Online: May, 1983.

NTP (National Toxicology Program). 1983. Chemicals on Standard Protocol: Management Status Report. April 20, 1983.

Ouellette, R.P. and J.A. King. 1977. Chemical Week Pesticides Register. McGraw-Hill Book Co., NY. p. 174.

Pimentel, D. 1971. Ecological Effects of Pesticides on Non-Target Species. Washington, DC. EPA 540/9-71-006. NTIS PB 269-605.

Ray, D.E. 1980. Selective inhibition of thermogenesis by tributyl S,S,S-phosphorotrithioate (DEF). Br. J. Pharmacol. 69(2): 257-264.

Sanders, H.O. 1969. Toxicity of pesticides to the crustacean, Gammarus lacustris. Tech. Paper 25, Bur. Sport Fish. Wildl., USDI. (Cited in Pimentel, 1971)

Sanders, H.O. 1970. Pesticide toxicities to tadpoles of the western chorus frog, Pseudacais triscriata, and Fowler's toad, Bufo woohousii foicieri. Copeia. 2: 246-251. (Cited in Pimentel, 1971)

Sanders, H.O. and O.B. Cope. 1968. The relative toxicities of several pesticides to naiads of three species of stoneflies. Limnol. Oceanogr. 13(1): 112-117.

SRI (Stanford Research Institute). 1976. Chemical Economics Handbook. Chemical Product Groups. Pesticides 573.0000-575.9999. Stanford Research Institute, Menlo Park, CA. 573.7003 U-V.

SRI International. 1982. Directory of Chemical Producers, United States of America. SRI International, Menlo Park, CA.

SRI International. 1983. Directory of Chemical Producers, United States of America. SRI International, Menlo Park, CA.

Stanly, C.W., J.E. Barney, II, M.R. Helton and A.R. Yobs. 1971. Measurement of atmospheric levels of pesticides. Environ. Sci. Technol. 5(5): 430-435.

Ubaidullaev, R. and T.S. Khasanov. 1979. Hygienic standards for hexachloran, fozalone, and butyphos in the air when these pesticides are used sequentially in agriculture. Gig. Sanit. 44(9): 14-17. (Rus.) (Taken from PESTAB 80/0394).

U.S. EPA. 1981. Acetate, aldicarb, carbophenothion, DEF, EPN, ethoprop, methyl parathion, and pharate: Their acute and chronic toxicity, bioconcentration potential, and persistence as related to marine environments. Prepared for the Office of Pesticides and Toxic Substances by Environmental Research Laboratory, Gulf Breeze, FL. EPA 600/4-81-041. PB 81-244477. 275 p.

U.S. EPA. 1983. 1977 TSCA (Toxic Substances Control Act). Production File. Online: May, 1983.

U.S. EPA/NIH. 1983. SANSS (Structure and Nomenclature Search System). Searched through CIS Online: May, 1983.

Woodrow, J.E., D.G. Crosby and J.N. Seiber. 1983. Vapor-phase photochemistry of pesticides. Residue Rev. 85: 111-125.

Walsh, G.E. and S. Alexander. 1980. A marine algal bioassay method: Results with pesticides and industrial wastes. Water Air Soil Pollut. 13(1): 45-55.

Whitmore, D.H., Jr. and D.H. Hodges, Jr. 1978. In vitro pesticide inhibition of muscle esterases of the mosquitofish, Gambusia affinis. Comp. Biochem. Physiol. C. 59C(2): 145-149.

Zak, P.I.R. and T.S. Ergashev. 1980. Experimental study of the effect of pesticide Butifos on female gonads. Med. Zh. Uzb. (2): 48-50. (Rus.) (Taken from PESTAB 80/2135).

APPENDIX: LITERATURE SEARCHED

This profile is based on data identified by computerized literature searches of:

CA SEARCH (Files 308, 309, 310, 311, 320)
TOXLINE
MEDLINE
RTECS
SCI SEARCH
OHM TADS
STORET
SRC Environmental Fate Data Bases
SANSS
AQUIRE

These searches were conducted in May, 1983. In addition, hand searches were made of Chemical Abstracts (Collective Indices 7th and 8th), and the following secondary sources were reviewed:

ACGIH (American Conference of Governmental Industrial Hygienists). 1980. TLVs: Documentation of the Threshold Limit Values, 4th ed. (Includes Supplemental Documentation, 1981). Cincinnati, OH. 486 p.

ACGIH (American Conference of Governmental Industrial Hygienists). 1982. TLVs: Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment. Cincinnati, OH. 94 p.

BCPC (British Crop Protection Council). 1977. Pesticide Manual, 5th ed., H. Martin and C.R. Worthing, Ed. British Crop Protection Council. 593 p.

Clayton, G.D. and F.E. Clayton, Ed. 1981. Patty's Industrial Hygiene and Toxicology, 3rd rev. ed., Vol. 2A. John Wiley and Sons, NY. 2878 p.

Clayton, G.D. and F.E. Clayton, Ed. 1981. Patty's Industrial Hygiene and Toxicology, 3rd rev. ed., Vol. 2B. John Wiley and Sons, NY. 2879-3816 p.

Clayton, G.D. and F.E. Clayton, Ed. 1982. Patty's Industrial Hygiene and Toxicology, 3rd rev. ed., Vol. 2C. John Wiley and Sons, NY. 3817-5112 p.

Grayson, M. and D. Eckroth, Ed. 1978-1983. Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed. John Wiley and Sons, NY. 23 Volumes.

Hamilton, A. and H.L. Hardy. 1974. Industrial Toxicology, 3rd ed. Publishing Sciences Group, Inc., MA. 575 p.

ITII (International Technical Information Institute). 1982. Toxic and Hazardous Industrial Chemicals Safety Manual for Handling and Disposal with Toxicity and Hazard Data. ITII, Tokyo, Japan. 700 p.

NTP (National Toxicology Program). 1983. Carcinogenesis Testing Program. Chemicals on Standard Protocol. Management Status.

Ouellette, R.P. and J.A. King. 1977. Chemical Week Pesticide Register. McGraw-Hill Book Co., NY.

Sax, I.N. 1979. Dangerous Properties of Industrial Materials, 5th ed. Van Nostrand Reinhold Co., NY.

SRI (Stanford Research Institute). 1983. Directory of Chemical Producers. Stanford, CA.

U.S. EPA. 1982. Chemical Activities Status Report, 3rd ed. (EPACASR). Offices of Pesticides and Toxic Substances, Washington, DC. EPA 560/TIIS-82-002b.

U.S. EPA. 1982. Status Report on Rebuttable Presumption Against Registration (RPAR) or Special Review Process. Registration Standards and the Data Call In Program. Office of Pesticide Programs, Washington, DC.

U.S. EPA. 1983. CHIB Existing Chemical Assessment Tracking System. Name and CAS Number Ordered Indexes. Office of Toxic Substances, Washington, DC.

USITC (United States International Trade Commission). 1982. Synthetic Organic Chemicals. U.S. Production and Sales, 1981. Washington, DC.

Verschueren, K. 1983. Handbook of Environmental Data on Organic Chemicals, 2nd ed. Van Nostrand Reinhold Co., NY.